

REVISIONS				
SYMBOL	PREP BY	DESCRIPTION	DATE	APPROVAL

APPROVAL

S-311-339

Goddard Space Flight Center
Greenbelt, Maryland
20771

1.0 SCOPE

1.1 Scope. This specification covers the general provisions for fiber optic cables intended for use in space flight and critical ground-support equipment (GSE) applications.

1.2 Part number. The part number shall consist of the number of this specification followed by the detail specification slash number and applicable dash number (see 3.1); e.g. S-311-339/1-1.

1.3 Cable types. Cables shall be of a flexible, single fiber type, which are coated with a buffer, provided with braided strength members and covered by a protective outer jacket. Cable types shall include multimode and single mode fibers, step and graded index profiles and loose and tight buffers.

2.0 APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bid or request for proposal, form a part of this specification to the extent specified herein.

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts
 MIL-STD-794 - Part and Equipment, Procedures for Packaging and Packing of,
 Defense Logistic Services Center
 DOD-STD-1678 - Fiber Optics Test Methods and Instrumentation

Other Publications

Handbook H4/H8 - Commercial and Government Entity (CAGE) Handbook
 ASTM-E-595-77 - American Society for Testing Materials (ASTM) Standard Test
 Methods for Materials Outgassing in Vacuum
 EIA-455 - Electronics Industry Association (EIA) Standard Test
 Procedures for Fiber Optic Parts (as specified)

2.2 Copies of documents. Copies of military and federal documents should be obtained from the appropriate contracting activity, or as directed by the contracting officer. Other publications are available through the preparing organizations, libraries, or other information services.

2.3 Order of precedence. For purpose of interpretation, in case of conflicts, the following order of document precedence shall apply:

- (a) Detail specification. The detail specification shall have precedence over the general specification.
- (b) General specification. This specification shall have precedence over all documents listed in 2.1.

3.0 REQUIREMENTS

3.1 Detail specification. The individual cable requirements shall be as specified herein and in accordance with the applicable detail specification.

3.2 Classification of requirements. The requirement classifications herein are as follows:

<u>Requirement</u>	<u>Paragraph</u>
Qualification	3.3
Identification	3.4
Materials	3.5
Visual Examinations	3.6
Performance	3.7

3.3 Qualification. Fiber optic cables furnished under this specification shall be products which have been granted qualification approval by the Goddard Space Flight Center (GSFC). Approval shall be based on the product having passed the qualification inspection requirements of this specification (see 6.3).

3.3.1 Qualification by similarity. Qualification may be granted on the basis of similarity to cables which differ only in minor details from those submitted for qualification testing. Qualification is contingent on the degree of similarity, as determined by the GSFC.

3.3.2 Loss of qualification. Qualification shall be withdrawn following any change in the design, processing, materials, or quality control procedures, which in the opinion of the GSFC significantly departs from those used on the qualified cable. In addition, qualification may be withdrawn as a result of discrepancies noted by the GSFC, the procuring activity, or for failures experienced in equipment which are attributable to the manufacturer's product. The manufacturer may apply for requalification of the cable after it has been demonstrated that satisfactory measures were taken to correct the conditions leading to the loss of qualification.

3.4 Identification.

3.4.1 Fiber optic cable identification. The cable identification consists of the part number (see 1.2) and the date-lot identification (see 3.4.2).

3.4.2 Date-lot identification. The manufacturer shall be responsible for the assignment of a date and lot identification code which will reflect the year and week of production and the numerical order of the lots produced during the week of production. The GSFC shall be provided with the key to the date-lot code. Once established, the manufacturer's date-lot identification shall not be changed without notifying the GSFC.

3.4.3 Identification marking. Each cable and packaging (see 5.3) shall be permanently and legibly marked (or tagged) with the cable part number and manufacturer's code designation in accordance with catalog in Handbook H4/H8. Color is optional but shall be contrasting to the cable jacket. Cables failing to meet all of the requirements of this specification shall not have the defined cable identification. All cable marking materials shall meet GSFC outgassing requirements (see 3.7.9)

3.4.3.1 Abrasion resistance. When cables are tested as specified in 4.7.19, the marking shall remain legible and cable shall pass visual examination (see 3.6). This test is not required when the marking is under a clear jacket.

3.5 Materials, design, and construction. Cables shall be of the materials, design, construction, and physical dimensions as specified herein and in the detail specification (see 3.1). Materials that outgas excessively in a hard vacuum shall not be used. The cables shall be uniform in appearance and free from cracks, scratches, and other defects which may reduce serviceability. Materials shall not affect the environment, and toxic materials shall not be used. Cable design shall be such that adequate protection is given to the fiber in normal assembly, test and use.

3.6 Visual examination. When cables are examined and tested as specified in 4.7.2, cables shall conform with all requirements of this and the detail specification. The cables shall show no evidence of defects or damage such as cracks, breaks, dents, kinks, nonuniformity, abrasions, delaminations, contamination, imbedded foreign material, nor improper or illegible cable marking.

3.6.1 Dimensions. When cables are examined as specified in 4.7.3, the diameters shall be as specified in the detail specification.

3.6.2 Weight. When examined as specified in 4.7.4, cables shall have a weight per length in grams per meter, as specified in the detail specification.

3.7 Performance. Unless otherwise specified in the detail specification, the performance requirements shall be as specified herein.

3.7.1 Attenuation. When cables are tested as specified in 4.7.5, the maximum attenuation shall not exceed the value specified in the detail specification.

3.7.2 Bandwidth. When tested as specified in 4.7.6, cables shall meet the specified limits of the detail specification.

3.7.3 Temperature Life. When tested as specified in 4.7.7, cables shall meet the visual examination criteria of 3.6, and attenuation shall not exceed the value specified in the detail specification.

3.7.4 Ionizing radiation. When tested as specified in 4.7.8, cable attenuation values shall be as specified in the detail specification.

3.7.5 Temperature cycling. When tested as specified in 4.7.9, cables shall meet the visual examination criteria of 3.6, and attenuation shall not exceed the value specified in the detail specification.

3.7.6 Moisture resistance. When tested as specified in 4.7.10, cables shall meet the visual examination of 3.6, and attenuation shall not exceed the value specified in the detail specification.

3.7.7 Twist bend. When tested as specified in 4.7.11, cable attenuation shall not exceed the value specified in the detail specification. Visual examination shall reveal no cracking, splitting, softening, or other surface defects that would permit jacket penetration.

3.7.8 Tensile load. When tested as specified in 4.7.12, cable attenuation shall not exceed the value specified in the detail specification. Visual examination shall reveal no cracking, splitting, or breaking of the cable components, or elongation greater than 2 percent.

3.7.9 Vacuum effects (material outgassing). When cables are tested as specified in 4.7.13, material outgassing shall not exceed the limits of 1% Total Mass Loss (TML) and 0.1% Collected Volatile Condensable Materials (CVCM).

3.7.10 Impact resistance. When tested as specified in 4.7.14, cable attenuation shall not exceed the value specified in the detail specification. Visual examination of the cable shall reveal no cracking, splitting, or other surface damage that would permit jacket penetration. Exterior deformation shall not be considered as a failure.

3.7.11 Flammability. When tested as specified in 4.7.15, cables shall not be flammable as defined by the test method. The duration of the after-flame and distance of flame travel shall be as specified in the detail specification.

3.7.12 Crush. When tested as specified in 4.7.16, cable attenuation shall not exceed the value specified in the detail specification. Visual examination shall show no cracking, splitting, or other surface damage that would permit jacket penetration. Cable exterior deformation shall not be considered as a failure.

3.7.13 Radiation pattern (Numerical aperture). When cables are tested as specified in 4.7.17, the measured values for the radiation pattern and calculated numerical aperture (N.A.) shall conform to those specified in the detail specification.

3.7.14 Thermal characteristic. When tested as specified in 4.7.18, cables shall not exceed the values for attenuation over the rated temperature range as specified in the detail specification.

3.7.15 Vibration - When tested as specified in 4.7.20, cable attenuation shall not exceed the value specified in the detail specification, during and after test, and the cables shall meet the visual examination criteria of 3.6.

3.7.16 Shock - When tested as specified in 4.7.21 cable attenuation shall not exceed the value specified in the detail specification during and after test and the cables shall meet the visual examination requirements of 3.6.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified, the manufacturer is responsible for the performance of all qualification and quality conformance inspections as specified herein and in the detail specification. The GSFC reserves the right to reinspect cables for any requirements deemed necessary and to designate representatives for in-plant surveillance and acceptance functions in connection with procurement of fiber optic cables to this and the detail specification.

4.2 Classification of inspection. The inspection of fiber optic cables shall be classified as follows:

- (a) Qualification inspection (4.4)
- (b) Quality conformance inspection (4.5)

4.3 Inspection conditions. Unless otherwise specified, all tests, measurements, inspections, and examinations required by this and the detail specification shall be conducted under any combination of conditions within the following ranges:

- (a) Temperature: +18° to +30°C (+65° to +86°F)
- (b) Relative humidity: 30 to 80 percent
- (c) Barometric pressure: 24 to 31 inches of mercury

4.3.1 Optical measurements. Optical measurements require special procedures for proper termination of cable and fibers. All cable fibers to be tested shall have their acceptance angle fully filled (light power across the fiber cross-section shall be uniform) and all cladding modes shall be stripped at the input end of the test fiber. Cable ends shall be terminated with the appropriate connectors (see 3.1).

4.3.2 Precautions for personnel safety. Care shall be taken when connecting and handling the sharp fine diameter glass optical fibers to prevent skin puncture or eye damage. Also, direct and magnified viewing of the optical port while it is transmitting light energy is not recommended. Use of eye protection and filters is recommended.

4.4 Qualification inspection. Qualification inspection shall consist of the examinations and tests of Table I. Inspections shall be performed on cables produced with equipment and procedures normally used in production. Groups IA and IB tests and examinations shall be performed before Groups II, III, or IV. The sequence of tests within each Group shall be as shown in Table I, and shall be performed on all specimens assigned to the Group.

4.4.1 Sample. The sample length of each cable type submitted for qualification inspection shall be a minimum of 100 meters.

4.4.2 Specimen. Unless otherwise specified in the detail specification, a specimen shall be a 10 meter length of cable taken from the sample (see 4.4.1). The specimens shall be taken from the sample length following the Group IA tests.

4.4.3 Qualification rejection. The failure of the sample length to meet Group IA requirements, or a failure of any specimen, shall be cause for refusal to grant qualification.

4.4.4 Disposition of qualification sample and specimen units. Cables subjected to qualification inspection (destructive tests) are not acceptable for a contract or order.

4.5 Quality conformance inspections.

4.5.1 Inspection of product for delivery. Inspections of product for delivery shall consist of Group A inspections of Table II. Any product which fails to meet any of the test and examination requirements of Table II shall be rejected and shall not be delivered on the order.

4.5.1.1 Inspection lot. An inspection lot is defined as that production run of continuous cable length from which the product for delivery will be drawn.

TABLE I. Qualification inspection.

Examination or test	No. of samples or specimens to be tested	Requirement paragraph	Test paragraph
<u>Group IA</u>	Entire sample		
Group A inspection - - - - -		Table II	4.5.1
Radiation pattern - - - - -		3.7.13	4.7.17
Bandwidth - - - - -		3.7.2	4.7.6
<u>Group IB</u>	1 specimen ^{1/}		
Flammability - - - - -		3.7.11	4.7.15
Vacuum effects, outgassing - -		3.7.9	4.7.13
Abrasion resistance - - - - -		3.4.3.1	4.7.19
<u>Group II</u>	3 specimens		
Thermal characteristics - - - -		3.7.14	4.7.18
Temperature cycling - - - - -		3.7.5	4.7.9
Ionizing radiation - - - - -		3.7.4	4.7.8
Temperature life - - - - -		3.7.3	4.7.7
<u>Group III</u>	3 specimens		
Moisture resistance - - - - -		3.7.6	4.7.10
Twist-bend - - - - -		3.7.7	4.7.11
<u>Group IV</u>	3 specimens		
Vibration - - - - -		3.7.15	4.7.20
Shock - - - - -		3.7.16	4.7.21
Tensile load - - - - -		3.7.8	4.7.12
Impact - - - - -		3.7.10	4.7.14
Crush - - - - -		3.7.12	4.7.16

^{1/}. Separate, unterminated segments of the specimen shall be assigned to each Group IB test.

TABLE II. Group A inspection.

Examination or test	Requirement paragraph	Test paragraph
Visual examination - - - - -	3.6	4.7.2
Physical dimensions - - - - -	3.6.1	4.7.3
Attenuation - - - - -	3.7.1	4.7.5
Weight - - - - -	3.6.2	4.7.4

4.6 Documentation and data submittal.

4.6.1 Required records. Fiber optic cables manufactured under this specification shall be supported by suitable records showing compliance with specified requirements. The manufacturer's quality assurance personnel must certify the test and inspection results, and this fact should be indicated on the cable certification record by means of inspection stamps, signatures, or other approved methods. Records shall be linked to a specific fiber optic cable lot by type designation and lot-date code. The manufacturer shall certify that each fiber optic cable meets all applicable specification requirements. A copy of this certification shall accompany each shipment, identifying the cables and types so certified. The manufacturer shall prepare the required documentation. The original is retained by the manufacturer.

4.6.2 Document cross-referenced. All documentation, whether retained or submitted by the manufacturer, shall be cross-referenced to the applicable contract or purchase order.

4.6.3 Record retention. All records pertinent to a specific cable shall be retained by the manufacturer for a minimum of 3 years.

4.7 Test methods

4.7.1 Preparation of specimens and samples. Specimen and sample cable lengths of each type cable shall be serialized. Serialization shall be maintained throughout all tests and examinations (see 3.1).

4.7.2 Visual examination (see 3.6). Visual examinations shall be performed in accordance with Electronics Industry Association EIA-455-13 standard to verify that cable design, construction, marking and workmanship are in accordance with the requirements of 3.6. Visual examination of the cable jacket shall be made at high power illumination under three-power magnification, and confirmed under ten-power whenever results at the lower magnification are uncertain or there is evidence of deficiencies that require greater resolution.

4.7.3 Dimensions (see 3.6.1). Cable dimensions shall be measured in accordance with EIA-455-13. Micrometer methods shall be used to verify jacket diameter limits specified in the detail specification. A minimum of four measurements shall be made on each cable length, in proportion to cable length. Fiber measurements shall be made at the cable ends.

4.7.4 Weight (see 3.6.2). Cable weight shall be determined per unit length in grams per meter. Scales shall be accurate to $\pm 5\%$.

4.7.5 Attenuation (see 3.7.1). Cable attenuation shall be tested in accordance with EIA-455-46 and EIA-455-50 except that the launch conditions shall be as specified in EIA-455-53. Test data shall include cable length, measurement values, accuracy and tolerances. Cable lengths for qualification inspection shall be the lengths specified in Table I. The length for quality conformance inspection shall be the length of the cable to be delivered.

4.7.6 Bandwidth (see 3.7.2). Cables shall be measured at 25°C in accordance with EIA-455-30 or EIA-455-51 and as described herein. Cable length shall be the entire sample length, per Table I.

4.7.7 Temperature Life (see 3.7.3). Cables shall be tested in accordance with EIA-455-4. The test temperature shall be the maximum rated value. The time shall be 2,000 hours with attenuation measured (see 4.7.5) at 25°C initially and at 500, 1,000, 1,500 and 2,000 hours of test.

4.7.8 Ionizing radiation (see 3.7.4). Cables shall be tested in accordance with EIA-455-49, except that the attenuation measurement shall be per 4.7.5. Cables shall be exposed to a total dose irradiation of 1 megarad(Si) from a cobalt 60 gamma ray source. Radiation shall be incident perpendicular to the cable axis. Attenuation shall be measured (see 4.7.5) at interim dose levels of 3K, 5K, 10K, 50K, 100K and 1 megarad(Si). Dose rates shall be 50 rads/min up to and including 10 K rads total dose and 500 rads/min at greater than 10K to 1 megarad (Si).

4.7.9 Temperature cycling (3.7.5). Cables shall be tested in accordance with EIA-455-3 and as described herein. A single chamber shall be used, rate of temperature change shall be 10°C/min and the temperature shall be over the rated range (see 3.1). Attenuation measurements (see 4.7.5) shall be made during and after the tests and visual examination performed after the tests.

4.7.10 Moisture resistance (see 3.7.6). Cables shall be submitted to the moisture resistance test in accordance with DOD-STD-1678, method 4030 and as described herein. Attenuation measurements (see 4.7.5) shall be made during and after the tests and visual examination performed after the tests.

4.7.11 Twist-bend (see 3.7.7). Cables shall be tested in accordance with EIA-455-91. Unless otherwise specified in the detail specification, the number of cycles shall be 2,000. Attenuation (see 4.7.5) shall be measured during and after the test and visual examination performed after the test.

4.7.12 Tensile load (see 3.7.8). The cables shall be mounted in such a way that the load may be applied axially per EIA-455-89. The load shall be applied gradually. A suitable device shall be used to measure the load to determine conformance with the limits specified in the detail specification. Attenuation (see 4.7.5) shall be measured during and after the test and visual examination performed after the test.

4.7.13 Vacuum effects (material outgassing) (see 3.7.9). Cables shall be tested as specified in ASTM-E-595-77 for Total Mass Loss (TML) and Collected Volatile Condensable Materials (CVCM). The segments of the cable tested shall include portions of the identification marking.

4.7.14 Impact resistance (see 3.7.10). Cables shall be tested in accordance with EIA-455-25 and as described herein. Attenuation (see 4.7.5) shall be measured during and after the test and visual examination performed after the test.

4.7.15 Flammability (see 3.7.11). Cables shall be tested in accordance with DOD-STD-1678, method 5010 and as described herein. When so tested, the duration of the after-flame and distance of flame travel shall be measured.

4.7.16 Crush (see 3.7.12). Cables shall be subjected to crush tests in accordance with EIA-455-26A and as specified herein (compressive strength). Attenuation (see 4.7.5) shall be measured during and after the crush test and visual examination shall be performed after the test.

4.7.17 Radiation pattern (see 3.7.13). The cables shall be measured in accordance with EIA-455-47 and as specified herein. Cable length shall be the entire sample length, as required in Table I.

4.7.18 Thermal characteristic (see 3.7.14). Cables shall be tested in accordance with DOD-STD-1678, method 4010 and as specified herein. The cables shall be measured for attenuation (see 4.7.5) at 25°C and at 20°C increments to the rated temperature extremes.

4.7.19 Abrasion resistance. Cables shall be tested in accordance with EIA-455-66 and as specified herein. At the completion of the tests, cables shall be examined as specified in 4.7.2 and meet requirements of 3.4.3.1.

4.7.20 Vibration (see 3.7.15). Cables shall be submitted to vibration tests in accordance with EIA-455-11. Peak acceleration shall be 20G. Attenuation (see 4.7.5) shall be measured during and after the test. Visual examinations shall be made after test.

4.7.21 Shock (see 3.7.16). Cables shall be submitted to shock tests in accordance with EIA-455-14 Cond. A and as specified herein. The shock shall be applied perpendicular to the light transmission axis. Peak acceleration shall be 50G. Attenuation (see 4.7.5) shall be measured during and after test. Visual examinations shall be made following the test.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging. Cable packaging shall be in accordance with Level A requirements of MIL-STD-794 and as specified herein. Cables shall be packaged in individual polypropylene film packages. The manufacturer shall be responsible for packaging fiber optic cables in a manner which prevents degradation, contamination, deterioration, or physical damage, and for ensuring the packages have a safe delivery and are in good condition. The manufacturer shall be responsible for any damage to or deterioration of the fiber optic cables resulting from faulty or improper packing, preservation, or packaging, and shall replace such fiber optic cables with acceptable cables without cost to the GSFC or to the procuring activity.

5.1.1 Cable ends. Cable ends shall be protected from contamination and damage by capping, or other suitable means.

5.2 Packing. Packing (handling and shipping of external containers) shall be in accordance with Level C of MIL-STD-794.

5.3 Marking. Unless otherwise specified, in the detail specification, each reel or spool shall be marked with the lengths of the individual continuous cables wound thereon. In addition, interior packages and exterior shipping containers shall be marked with the following information:

CABLE, FIBER OPTICS

Specification part No. (e.g. S-311-339/1-1)
Length of cable in meters
Date of manufacture
Name and address of manufacturer

6.0 NOTES

6.1 Data address. When supplemental data, reports, or information requests are to be transmitted to the GSFC, the following address shall be used unless otherwise specified:

Parts Branch, Code 311
Goddard Space Flight center
Greenbelt, Maryland 20771

6.2 Ordering data. Procurement documents shall specify the following:

- (a) Title, number, and date of this and the applicable detail specification
- (b) Fiber optic cable part number (see 1.2)

6.3 Qualification provisions. With respect to products requiring qualification, awards will be made only for products which have been approved by the GSFC before the time set for opening of bids. Information pertaining to qualification of products may be obtained from the activity whose address is listed in 6.1.

6.4 Notice. When the GSFC drawings, specifications, or other data are used for any purpose other than in connection with a definitely related GSFC procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; the fact that the GSFC might have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

6.5 Definitions. Definitions of terms shall be in accordance with DOD-STD-1678.

Custodian:
Parts Branch
Code 311
Goddard Space Flight Center
Greenbelt, Maryland 20771